MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, 2017/2018

EEE3096 – COMMUNICATION ELECTRONICS

(TE)

14 OCTOBER 2017
2:30 P.M. – 4:30 P.M.
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This Question paper consists of 7 pages with 4 Questions only.
2. Attempt **ALL FOUR** questions.
3. Please print all your answers in the Answer Booklet provided.

Question 1

(a) Explain briefly the usage of attenuator in a typical communication system. State the differences between attenuator and amplifier.

[5 marks]

(b) Two cascaded attenuators are used to reduce the source voltage to load R_L, as shown in Figure Q1a. It is required that the image impedance looking into the input of the attenuator be equal to the load resistor.

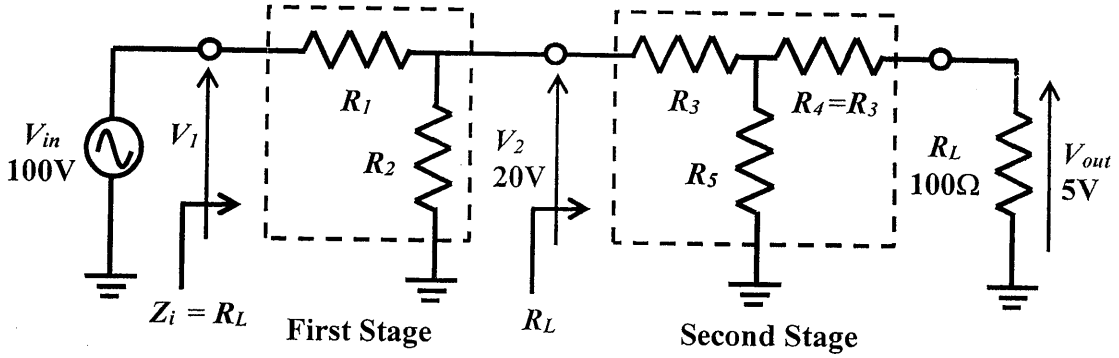

Figure Q1a

(i) Name the type of attenuators used in the first and second stages.

[2 marks]

(ii) For each stage, determine the attenuation factor (in dB). What is the total attenuation factor (in dB) for this cascaded system?

[3 marks]

(iii) Calculate the values of R_1, R_2, R_3, R_4 and R_5.

[5 marks]

(c) Consider the unloaded parallel resonant RLC circuit shown in Figure Q1c. Calculate the resonant frequency, Q and 3-dB bandwidth.

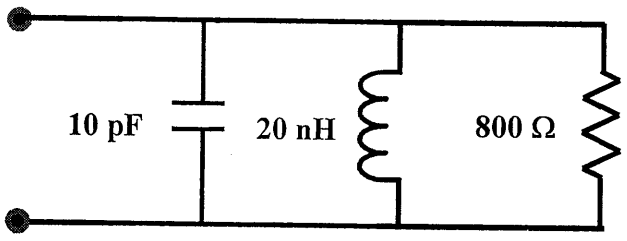

Figure Q1c

[6 marks]

(d) Explain briefly TWO (2) importance of impedance matching in a typical communication system.

[4 marks]

Continued .....

Question 2

(a) State THREE (3) advantages of a tuned amplifier.

[3 marks]

(b) A radio frequency (RF) Class A amplifier is shown in Figure Q2b. The transistor has the following parameters: β = 100, $r_{bb'}$ =100 Ω, h_{fe} = 230, V_A= 50V, C_C = 3pF, f_T =250MHz and V_{BE} = 0.7 V. The amplifier is designed to operate at 15 MHz with an operating bandwidth of 1 MHz.

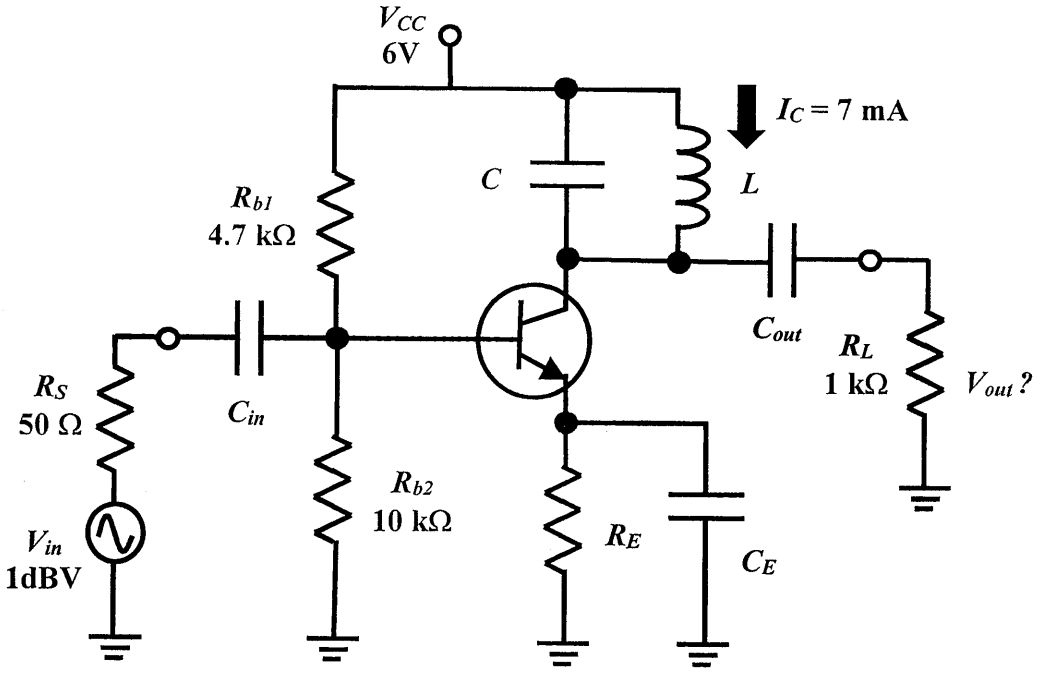

Figure Q2b

(i) State the transistor configuration used in this amplifier

[1 mark]

(ii) Describe briefly the functions of capacitors, C_{in} and C_{out}. Also, suggest a suitable values for these capacitors

[3 marks]

(iii) Draw the dc equivalent circuit and perform a dc analysis of the circuit to determine the required emitter resistance, R_E when the dc collector current I_C = 7 mA.

[6 marks]

(iv) Draw the hybrid-π model of the circuit in high frequency ac analysis employing Miller's capacitance. Label all relevant elements in the model with the corresponding numerical value.

[8 marks]

Continued .....

(v) Determine the numerical value of inductance L and capacitance C of the tank network.

[2 marks]

(vi) Determine the output voltage, V_{out} (in dBV) at the load of the transistor amplifier, if the input voltage, V_{in} = 1 dBV.

[2 marks]

Question 3

(a) Define the following parameters for the Phase Lock Loop (PLL) in communication electronics:

(i) Capture range, and

(ii) Lock range.

[2 + 2 marks]

(b) A PLL frequency synthesizer shown in Fig. Q3b is used as local oscillator to select different channels for a dual intermediate frequency (IF) conversion receiver.

(i) Determine the crystal oscillator frequency, f_{XO}.

[2 marks]

(ii) List the frequencies appear after the first mixer in this receiver.

[2 marks]

(iii) Suggest the type of filter suitable for this receiver.

[2 marks]

(iv) Determine the IF frequency after the first mixer, f_{IF1} in this receiver.

[2 marks]

(v) List the frequencies appear after the second mixer in this receiver.

[2 marks]

(vi) Determine the IF frequency after the second mixer, f_{IF2} in this receiver.

[2 marks]

(vii) Calculate the required N for the programmable divider in the PLL, when the receiver is tuned to a radio frequency (RF) channel centered at frequency 480 MHz.

[3 marks]

(viii) Determine the resolution (the minimum difference in frequency between two adjacent channels) of the receiver.

[3 marks]

(ix) Determine the loop gain (k_L) of the PLL, when the receiver is tuned to a RF channel centered at frequency 480 MHz.

[3 marks]

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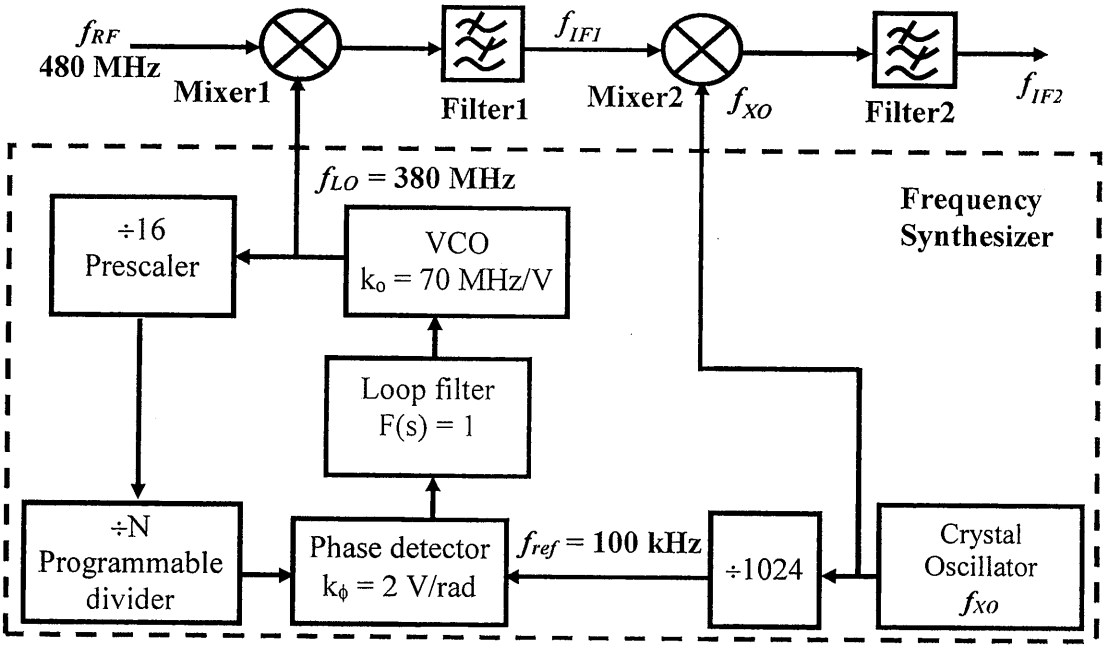

Figure Q3b

Question 4

(a) With the aid of suitable diagrams, explain the term "interlaced scanning" in the context of television.

[8 marks]

(b) A cable television (CATV) system with an input signal of 100 μV is shown in Figure Q4(b). Determine the following:

(i) The input signal level in dBmV.

[2 marks]

(ii) The output signal level (in V and dBmV) after Amplifier 1.

[2 marks]

(iii) The input and output signal level (in V and dBmV) before and after Amplifier 2.

[4 marks]

(iv) The input and output signal level (in V and dBmV) before and after Amplifier 3.

[4 marks]

(v) The input signal level (in V and dBmV) at the subscriber drop.

[2 marks]

(vi) The power (in W and dBm) delivered at the subscriber drop if the termination impedance is equal to 75 Ω.

[3 marks]

Continued .....

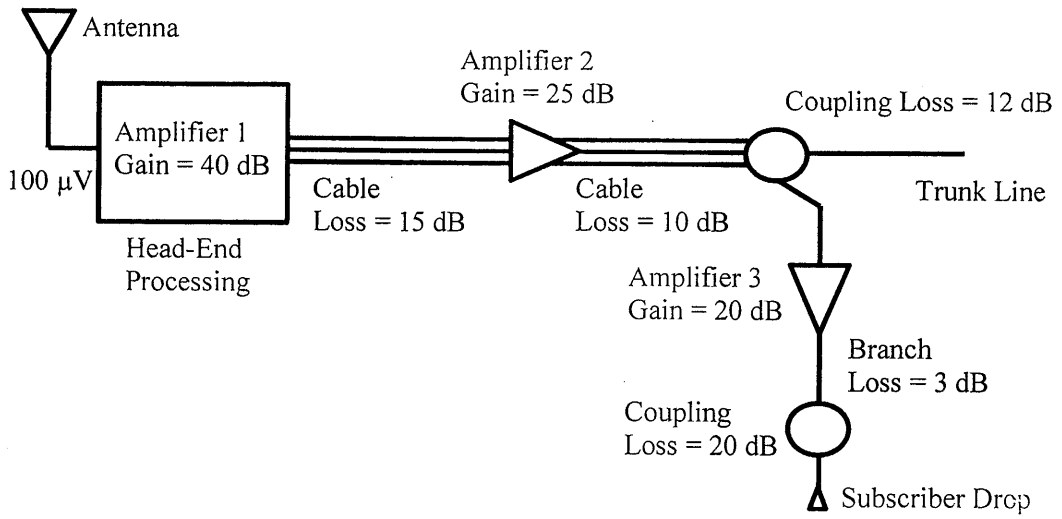

Figure Q4b

Appendix – Useful Formulas

1. RF Class A transistor amplifier (Hybrid π model of BJT)

$r_{bb'}$	**The base-spreading resistance.**
g_m	**The transconductance.** $g_m = \frac{dI_C}{dV_{BE}} = \frac{qI_C}{kT} \cong \frac{I_C(\text{in mA})}{25.875mV}$ at T=300K, q= electronic charge, $1.6\text{x}10^{-19}$C
C_e	**The emitter capacitance.**
$r_{b'e}$	**The input resistance.** $r_{b'e} = \frac{dV_{B'E}}{dI_B} = \frac{h_{fe}}{g_m}$
$r_{b'c}$	**The collector to base resistance.** $r_{b'c} = h_{fe}r_{ce}$
C_C	**The collector capacitance.**
r_{ce}	**The output resistance.** $r_{ce} \cong \frac{V_A}{I_C} = \frac{qV_A}{kTg_m}$ Where V_A is known as the Early voltage and I_C is the dc collector current.

Continued .....

2. High frequency Class A amplifier parameters:

(a) Voltage gain:

$$A_V = \frac{v_o}{v_{BE}} = -g_m R_o \frac{r_{b'e}}{r_{bb'} + r_{b'e}} \frac{1}{1 + j\omega C_T \frac{r_{bb'} r_{b'e}}{r_{bb'} + r_{b'e}}}$$

In cases where $r_{bb'} << r_{b'e}$ then

$$A_V = \frac{v_o}{v_{BE}} = -\frac{g_m R_o}{1 + j\omega C_T r_{bb'}}$$

(b) Effective voltage gain (including the effect of source impedance R_S):

$$A_{VS} = \frac{v_o}{V_S} = -g_m R_o \frac{r_{b'e}}{r_{bb'} + R_S + r_{b'e}} \frac{1}{1 + j\omega C_T \frac{(R_S + r_{bb'}) r_{b'e}}{R_S + r_{bb'} + r_{b'e}}}$$

In cases where $(R_s + r_{bb'}) << r_{b'e}$ then

$$A_{VS} = \frac{v_o}{V_S} = -\frac{g_m R_o}{1 + j\omega C_T (R_S + r_{bb'})}$$

Where $C_T = C_e + C_M$ and C_M = Miller capacitance $C_M = (1 + g_m R_o) C_C$

(c) Transition frequency

$$f_T = \frac{1}{2\pi} \frac{g_m}{C_e + C_C}$$

(d) Input impedance

$$Z_I = r_{bb'} + \frac{r_{b'e}}{1 + j\omega r_{b'e} C_T}$$

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